PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-223512
(43)Date of publication of application : 26.08.1997

(51)Int.Cl. H01M 8/04

(21)Application number : 08-028827
(22)Date of filing : 16.02.1996

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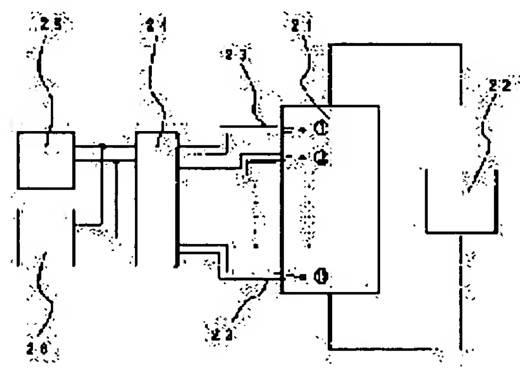
(54) ABNORMALITY MONITORING METHOD OF FUEL CELL AND DEVICE THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To accurately measure the generating electric current density distribution inside of a fuel cell, and precisely seize the existence of operational abnormality of the fuel cell.
SOLUTION: Thermocouples 23 are dispersively arranged inside a fuel cell 21, and a load current of the fuel cell 21 is changed in time by an electronic load device 22, and temperature outputs detected by the thermocouples 23 are selected by a multiplexer 24. The distribution is found by measuring its AC component by an AC voltmeter 26, and the in plane distribution of electric current density is seized by proportionally distributing the load current in a plane, and abnormality inside of the fuel cell 21 is seized by the existence of its abnormality.



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other

than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, and the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, The cel which consists of an electrolyte layer pinched by a fuel electrode and the oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. Conduction of the oxidizer gas is carried out to the oxidizer gas conduction slot with which the oxidizer electrode was equipped. This fuel gas and oxidizer gas The fuel cell which transforms the reaction energy of (calling it reactant gas hereafter) into power according to an electrochemical operation, It is the monitor approach of the abnormalities of the generation-of-electrical-energy current density within the field of said fuel electrode and an oxidizer electrode. The load current of a fuel cell is changed in time. Said fuel electrode substrate or an oxidizer electrode substrate, By calculating the generating heating value in this arbitration location from the time amount variation of temperature which measures the temperature in the arbitration location within one which is chosen from the group which consists of a reactant gas conduction slot and an electrolyte layer of fields, and follows the temporal response of said load current The abnormality monitor approach of the fuel cell characterized by measuring the generation-of-electrical-energy current density distribution in said electrode surface, and detecting the abnormalities of a fuel cell.
[Claim 2] The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, and the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, The cel which consists of an electrolyte layer pinched by a fuel electrode and the oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of reactant gas into power according to an electrochemical operation The thermometry component for which the emergency supervisory equipment of a fuel cell measures the temperature in the arbitration location within one which is chosen from the group which consists of said fuel electrode substrate or an oxidizer electrode substrate, a reactant gas conduction slot, and an electrolyte layer of fields, Emergency supervisory equipment of the fuel cell characterized by coming to have the measuring instrument which measures the alternating current component of the detection output of this thermometry component, and electronic load equipment which controls the load current of said fuel cell.
[Claim 3] Emergency supervisory equipment of the fuel cell characterized by said thermometry component being a thermocouple in the emergency supervisory equipment of a fuel cell according to claim 2.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the monitor approach of the abnormalities of the generation-of-electrical-energy current density in an electrode surface of fuel cells, such as a phosphoric-acid mold and a solid-state polyelectrolyte membrane type, and its emergency supervisory equipment.
[0002]
[Description of the Prior Art] Drawing 9 is the perspective view showing typically the basic configuration of the single cel of a phosphoric acid fuel cell. The oxidizer electrode which consists of an oxidizer electrode catalyst bed 2 and an oxidizer electrode substrate 1 the plate-like electrolyte layer 3 which consists of a matrix which supported the phosphoric acid, Pinch with the fuel electrode which consists of a fuel electrode catalyst bed 4 and a fuel electrode substrate 5, and it is constituted. Two or more oxidizer gas conduction slot 1a which carries out conduction of the oxidizer gas, such as air, is formed in the external surface of the oxidizer electrode substrate 1, and two or more fuel gas conduction slot 5a which carries out conduction of the fuel gas, such as hydrogen, to the external surface of the fuel electrode substrate 5 is formed in oxidizer gas conduction slot 1a and the rectangular direction. Thus, the laminating of the constituted single cel is carried out, and the phosphoric acid fuel cell is formed.
[0003] In such a configuration, since the hydrogen concentration in the fuel gas which flows fuel gas conduction slot 5a, and the oxygen density in the air which flows oxidizer gas conduction slot 1a will fall in connection with the electrochemical reaction in a field so that they go to an outlet side, they will fall as the generation-of-electrical-energy current density in a field also goes to an outlet from the inlet port of each gas. In the part which approached the fuel gas outlet and the air outlet in the part with high generation-of-electrical-energy current density by cell temperature serving as an elevated temperature relatively in the part close to a fuel gas inlet port and an air inlet since generation of heat was large and generation of heat became small in the part with low generation-of-electrical-energy current density, it becomes low temperature relatively. Thus, if the temperature distribution to produce become excessive, in an elevated-temperature part, the phosphoric acid in a matrix will evaporate and will become the cause which the phenomenon which is condensed and a phosphoric acid moves in a field produces in a low-temperature part. If this phenomenon continues over a long period of time, the superfluous part of a phosphoric acid and an insufficient part will arise in a field, and it will become the cause of reducing the life of a fuel cell. Therefore, it is necessary to supervise so that the difference in generation-of-electrical-energy current density may not become excessive.
[0004] Moreover, although the variation in the quality produced in a manufacture phase also becomes the factor which forms distribution of the generation-of-electrical-energy current density within a field, it is a technical problem also with the important quality control top of a fuel cell that

the distribution evaluates whether it is the inside of a normal range, and grasps. Thus, distribution of the generation-of-electrical-energy current density in a fuel cell is an index important when evaluating the property of a fuel cell.

[0005] As an approach of measuring generating current density distribution in the inside of the field of a fuel cell, and the direction of a laminating conventionally, ** and others is the Institute of Electrical Engineers of Japan paper magazine, for example about a phosphoric acid fuel cell. B, volume [109th] No. 4 (1989), and p.169 The announced approach is learned. Drawing 10 is the important section sectional view of a fuel cell showing the measurement approach of current density distribution of the fuel cell by them. The cathode of the first cel where 11 equipped the longitudinal direction of space with oxidizer gas conduction slot 11a in drawing (oxidizer electrode), The anode plate of the second cel where 13 was equipped with fuel gas conduction slot 13a in the direction of a vertical of space (fuel electrode), The cathode of the second cel where 14 equipped the longitudinal direction of space with the electrolyte layer of the second cel, and 15 was equipped with oxidizer gas conduction slot 15a, 17 is the anode plate of the third cel equipped with fuel gas conduction slot 17a in the direction of a vertical of space, and the division plate from which 12 separates the first cel and the second cel airtightly, and 16 are division plates which separate the first cel and the second cel airtightly. In this configuration, as shown in drawing, the potential measurement line of a pair is inserted in the predetermined location of oxidizer gas conduction slot 11a and fuel gas conduction slot 17a, and it is an electrical potential difference Vs. It measures. The potential measurement line of a pair is inserted in the location which furthermore faces the above predetermined location of fuel gas conduction slot 13a and oxidizer gas conduction slot 15a, and it is an electrical potential difference Ve. It measures and asks for the resistance fall of potential in the above predetermined location in the second cel by (Vs-Ve) / 2. Furthermore, current density is evaluated as what has the resistance fall of potential obtained by doing in this way, and current density in proportionality. By changing the point of measurement by the potential measurement line, and measuring the resistance fall of potential in the every place orientation of the inside of a field, and the direction of a laminating, distribution of the current density of the inside of a field and the direction of a laminating will be evaluated.

[0006] In addition, distribution of the hydrogen concentration in fuel gas by this invention person or the oxygen density distribution in oxidizer gas is measured, current density distribution is searched for from the distribution, and there is the approach (refer to Japanese Patent Application No. No. 26414 [seven to]) of supervising the abnormalities inside a fuel cell.

[0007]

[Problem(s) to be Solved by the Invention] As mentioned above, in the abnormality monitor of the conventional fuel cell, the resistance fall of potential inside a fuel cell is measured, and the approach of evaluating current density and supervising abnormalities from the value, is taken. However, it is impossible for the path and area in which a current flows in the case of measurement of resistance fall of potential to change with measuring points of resistance fall of potential, and to convert resistance fall of potential into current density correctly by this approach, since it is unknown. Therefore, since the field internal division cloth of the current density distribution acquired by this measuring method is accompanied by the great error, the abnormality monitor approach of the fuel cell by the current density of this measuring method has the trouble that accuracy is missing.

[0008] Moreover, in the approach of supervising the abnormalities inside a fuel cell in quest of current density distribution from distribution of the hydrogen concentration in fuel gas, or the oxygen density distribution in oxidizer gas, since the method of inserting for example, a stainless steel capillary in the interior of a fuel cell, and extracting and analyzing sample gas is taken, there is a difficulty that a certain amount of time amount is needed for searching for the distribution within a field.

[0009] This invention was made in consideration of the difficulty of the conventional technique like

the above, and by the simple approach, generating current density distribution of the inside of the field of a fuel cell and the direction of a laminating is measured correctly, and it aims at offering the abnormality monitor approach of a fuel cell that the existence of the abnormalities of actuation of a fuel cell is supervised exactly, and its equipment.

[0010]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, it sets to this invention. (1) The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, and the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, The cel which consists of an electrolyte layer pinched by a fuel electrode and the oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The load current of a fuel cell is changed in time. A fuel electrode substrate or an oxidizer electrode substrate, By calculating the generating heating value in the location from the time amount variation of temperature which measures the temperature in the arbitration location within one which is chosen from the group which consists of a reactant gas conduction slot and an electrolyte layer of fields, and follows the temporal response of the load current Suppose that the generation-of-electrical-energy current density distribution within a field is measured, the abnormality is detected, and the abnormalities of a fuel cell are supervised. Moreover, (2) The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The thermometry component which measures the temperature in the arbitration location within one which is chosen from the group which consists of the above-mentioned fuel electrode substrate or an oxidizer electrode substrate, a reactant gas conduction slot, and an electrolyte layer in the emergency supervisory equipment of a fuel cell of fields, for example, a thermocouple, Suppose that the measuring instrument which measures the alternating current component of the detection output of this thermometry component, and the electronic load equipment which controls the load current of the above-mentioned fuel cell are had and constituted.

[0011] the above (1) like -- if an approach is used, since the generating heating value in the location of the arbitration in an electrode surface can be computed theoretically and the generating heating value of each part of a fuel cell is proportional to generation-of-electrical-energy current density under a certain approximation on the other hand from the time amount variation of temperature which follows the temporal response of the load current, it is possible to ask for the generation-of-electrical-energy current density in this location. Therefore, the generation-of-electrical-energy current density distribution in an electrode surface can be searched for, and the existence of the abnormalities in a fuel cell can be detected.

[0012] In this approach, the generating heating value of the location can be known from the time amount variation of the temperature accompanying the temporal response of the load current based on the principle explained below. That is, it becomes that change of terminal voltage V [as opposed to / solve and / load current consistency / of the single cel of a phosphoric acid fuel cell / J [kA/m2]] [V] to which it was shown in drawing 9 , i.e., a voltage-current consistency property, (V-J property) is drawing 11 . Terminal voltage V falls under the effect of internal resistance etc. with the

increment in the load current consistency J. Generated output consistency P1 per unit area [W/m2] and loss power flux density P2 [kW/m2] is expressed with a degree type, respectively.
[0013]
[Equation 1] P1 =JxV (1) P2 =Jx (1.23-V) (2) P2 Since it is equal to the heating value generated inside a fuel cell, it is a formula (2). By trying to double the V-J property of drawing 11 shows that a generating heating value also increases by the increment in current density J. since the terminal voltage within an electrode surface serves as about 1 law by within the limits which is several mV with the phosphoric acid fuel cell of structure as shown especially in drawing 9 when the resistivity of a base material is sufficiently small -- generated output consistency P1 A generating heating-value consistency will be proportional to current density J mostly.
[0014] Now, when distribution of current density J exists within an electrode surface, the heating-value distribution by loss power is formed. The temperature distribution decided by this heating-value distribution and boundary condition turn into steady temperature distribution within a field. On the other hand, when an alternating current-modulation is applied, the temperature distribution of each point within a field are expressed with the sum of the alternating current component TAC which synchronized with the steady temperature distribution TDC decided by the current density JDC averaged in time, and the modulation current density JAC to the load current, so that it may illustrate to drawing 4 . Since distribution of the alternating current component of temperature is decided by alternating current thermal diffusion length mu [m] decided by modulation frequency, it is independent of steady temperature distribution. here -- thermal diffusion length [of the matter] mu [m] -- in k [W/m K] and a consistency, thermal conductivity will be given [heat capacity / rho [kg/m3] and] by the degree type, if C [J/m3] and modulation frequency are set to f [Hz] and a circular constant is set to pi.
[0015]
[Equation 2] mu = [k/(pifrhoC)] 1/2 Thermal diffusion length becomes short, so that (3), i.e., modulation frequency, is high, and temperature distribution will be determined by distribution of a heat source rather than boundary condition. [f] That is, when the load current is modulated on a frequency high enough, it can be considered that distribution of the alternating current component of the temperature produced in connection with this is generating heating-value distribution, therefore current density distribution.
[0016] moreover, the above (2) like -- the temperature of either the electrode substrate of a fuel cell, a gas conduction slot or an electrolyte layer being measured, for example, with the thermometry component which consists of a thermocouple If it has the measuring instrument which measures the alternating current component of the detection output of a thermometry component, and electronic load equipment which controls the load current of a fuel cell and the emergency supervisory equipment of a fuel cell is constituted Since the load current modulated on the high frequency with electronic load equipment is impressed to a fuel cell, the produced temperature fluctuation will be detected with a thermometry component, the alternating current component will be measured with a measuring instrument and current density will be known, the abnormalities produced within the fuel cell can be grasped exactly.
[0017]
[Embodiment of the Invention] Hereafter, the gestalt of operation of the abnormality monitor approach of the fuel cell of this invention and its equipment is explained using a drawing. Drawing 1 is the mimetic diagram showing the basic configuration of the emergency supervisory equipment used for the abnormality monitor approach of the fuel cell of this invention. The fuel cell with which 21 was manufactured experimentally, the electronic load equipment with which 22 controls the load current of a fuel cell, The thermocouple for thermometries with which 23 was inserted in the fuel cell, the multiplexer as which 24 chooses the output voltage of a thermocouple, the direct-current-voltage meter which measures an in one direction flowed part of the output voltage of the

thermocouple with which 25 was chosen, and 26 are alternating-voltage meters which measure the alternating component of the output voltage of the selected thermocouple.
[0018] It is a phosphoric acid fuel cell, and a fuel cell 21 carries out the laminating of five single cels, the 1st cel 31 - the 5th cel 35, as shown in drawing 2 R> 2, it arranges a cooling plate 36 up and down, respectively, and is formed. It solves, and consists of a configuration and the electrode surface product of a fuel cell of the area of 2 (1mx1m), among those a generation-of-electrical-energy field is [which showed each five single cel by which the laminating was carried out to drawing 9] 2 0.81m 1m (0.9 mx0.9 m). As fuel gas, it is hydrogen. 65 % and carbon dioxide As oxidizer gas, air is used for the mixed gas of 35 % again. Moreover, hydrogen utilization factor at the time of a generation of electrical energy 80 % and ratio of oxygen utilization It is 50 %.
[0019] Moreover, the fuel cell 21 equips with a total of 13 thermocouples 23 the 3rd cel 33 located in a center section among five single cels by which the laminating was carried out. These thermocouples 23 are all the outer diameters of 0.6mm. It is chromel-alumel thermocouple with a stainless steel sheath, it inserts in the oxidizer gas conduction slot (1a of drawing 9) of an oxidizer electrode, and the element is distributed so that it may become the location shown in drawing 3 by the sunspot. In addition, in drawing 3 , 33 shows the 3rd cel, therefore an electrode field, and 40 shows the generation-of-electrical-energy field.
[0020] In this configuration, fuel gas and air were supplied to the fuel cell 21, the load current was controlled by electronic load equipment 22, and the electrode temperature of each point of measurement was measured with it. The load current is between 10 [ms], as shown in drawing 4 . Between [after holding to 2.0 [kA]] ten [ms] The cycle held to 2.8 [kA] shall be repeated. Namely, average The load current of 2.4 [kA] was modulated on the frequency of 50 [Hz]. The output of each thermocouple 23 was led to the multiplexer 24, the dc component of the output voltage was measured with direct current voltage 25 [a total of] with the change, and the alternating current component was measured with alternating voltage 26 [a total of].
[0021] When measured the above condition, about the dc component of temperature which changes in time, the field internal division cloth like drawing 5 was obtained, and the field internal division cloth like drawing 6 was obtained about the alternating current component. Drawing 5 and drawing 6 are the generation-of-electrical-energy field 40. It is what displayed the temperature of the part of 0.9mx0.9 m, and the contour line computed from such measured value is displayed on the measured value of the location corresponding to the point of measurement shown in drawing 3 , and a list, and all of the unit of the described numeric value are [**s]. In drawing 5 , it is characteristic to decrease as the maximum upstream section of fuel gas and air serves as max and goes down-stream by drawing 6 to the neighborhood of a point of (300 mm, 300mm) on drawing near the upstream of fuel gas and air showing maximum.
[0022] On the other hand, perform numerical simulation, and the field internal division cloth of the temperature acquired about the above-mentioned fuel cell 21 based on change in the field of the hydrogen concentration in the fuel gas accompanying electrochemical reaction, change in the field of the oxygen density in air, or the boundary condition in an electrode edge is shown in drawing 7 , and the field internal division cloth of current density is shown in drawing 8 . It is what all displayed the distribution in the interior of the generation-of-electrical-energy field 40 as with the contour line, and the unit of the current density which showed the unit of the temperature shown in drawing 7 to [**] and drawing 8 is [kA/m2].
[0023] As it was predicted theoretically that drawing 6 was compared with drawing 8 , it turns out that distribution (drawing 6) of the alternating current component of the temperature measured by the above-mentioned approach is well in agreement with the field internal division cloth (drawing 8) of current density. That is, the variation of a sink and temperature is measured for the load current modulated to the fuel cell, distribution is searched for, and the field internal division cloth of current density is called for by distributing proportionally the generation-of-electrical-energy current

of a fuel cell in a field. Therefore, if an above-mentioned approach is used, the abnormalities of the current density inside a fuel cell will be detected correctly, and can supervise the abnormalities of a fuel cell exactly.

[0024] In addition, in the above-mentioned example, although the thermometry component which becomes the 3rd cel 33 of a fuel cell 21 from a thermocouple 23 shall be distributed, if a thermometry component is allotted to other single cels, the abnormalities between the single cels of the direction of a laminating will be detected. Moreover, although the thermometry component set to oxidizer gas conduction slot 1a from a thermocouple 23 was inserted and temperature is measured in the above-mentioned example, the effectiveness same also as measuring the temperature of not only a reactant gas conduction slot but an electrode substrate or an electrolyte layer is acquired. It is Princeton AppliedReseach as a measuring instrument of the alternating current component of a temperature change further again instead of an alternating-voltage meter. If the lock in amplifier currently manufactured at the shrine or the ENUEFU circuit design block company is used, the output voltage of the thermocouple which synchronized with change of the load current will be more highly precise, can measure, and is effective by the monitor of the abnormalities of a fuel cell.

[0025]

[Effect of the Invention] As mentioned above, according to this invention, it is (1). The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The load current of a fuel cell is changed in time. A fuel electrode substrate or an oxidizer electrode substrate, By calculating the generating heating value in the location from the time amount variation of temperature which measures the temperature in the arbitration location within one which is chosen from the group which consists of a reactant gas conduction slot and an electrolyte layer of fields, and follows the temporal response of the load current Since the generation-of-electrical-energy current density distribution within a field is measured, the abnormality is detected and the abnormalities of a fuel cell are supervised The abnormality monitor approach that the current density distribution within the field of a fuel cell can measure correctly, can evaluate by the simple approach, and grasps the existence of the abnormalities of a fuel cell exactly by it will be acquired.

[0026] (2) Moreover, the fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The thermometry component which measures the temperature in the arbitration location within one which is chosen from the group which consists of the above-mentioned fuel electrode substrate or an oxidizer electrode substrate, a reactant gas conduction slot, and an electrolyte layer in the emergency supervisory equipment of a fuel cell of fields, for example, a thermocouple, Having and constituting the measuring instrument which measures the alternating current component of the detection output of this thermometry component, and the electronic load equipment which controls the load current of the above-mentioned fuel cell, then the emergency supervisory equipment which the existence of the

abnormalities of a fuel cell can grasp exactly will be obtained.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the monitor approach of the abnormalities of the generation-of-electrical-energy current density in an electrode surface of fuel cells, such as a phosphoric-acid mold and a solid-state polyelectrolyte membrane type, and its emergency supervisory equipment.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Drawing 9 is the perspective view showing typically the basic configuration of the single cel of a phosphoric acid fuel cell. The oxidizer electrode which consists of an oxidizer electrode catalyst bed 2 and an oxidizer electrode substrate 1 the plate-like electrolyte layer 3 which consists of a matrix which supported the phosphoric acid, Pinch with the fuel electrode which consists of a fuel electrode catalyst bed 4 and a fuel electrode substrate 5, and it is constituted. Two or more oxidizer gas conduction slot 1a which carries out conduction of the oxidizer gas, such as air, is formed in the external surface of the oxidizer electrode substrate 1, and two or more fuel gas conduction slot 5a which carries out conduction of the fuel gas, such as hydrogen, to the external surface of the fuel electrode substrate 5 is formed in oxidizer gas conduction slot 1a and the rectangular direction. Thus, the laminating of the constituted single cel is carried out, and the phosphoric acid fuel cell is formed.
[0003] In such a configuration, since the hydrogen concentration in the fuel gas which flows fuel gas conduction slot 5a, and the oxygen density in the air which flows oxidizer gas conduction slot 1a will fall in connection with the electrochemical reaction in a field so that they go to an outlet side, they will fall as the generation-of-electrical-energy current density in a field also goes to an outlet from the inlet port of each gas. In the part which approached the fuel gas outlet and the air outlet in the part with high generation-of-electrical-energy current density by cell temperature serving as an elevated temperature relatively in the part close to a fuel gas inlet port and an air inlet since generation of heat was large and generation of heat became small in the part with low generation-of-electrical-energy current density, it becomes low temperature relatively. Thus, if the temperature distribution to produce become excessive, in an elevated-temperature part, the phosphoric acid in a matrix will evaporate and will become the cause which the phenomenon which is condensed and a phosphoric acid moves in a field produces in a low-temperature part. If this phenomenon continues over a long period of time, the superfluous part of a phosphoric acid and an insufficient part will arise in a field, and it will become the cause of reducing the life of a fuel cell. Therefore, it is necessary to supervise so that the difference in generation-of-electrical-energy current density may not become excessive.
[0004] Moreover, although the variation in the quality produced in a manufacture phase also becomes the factor which forms distribution of the generation-of-electrical-energy current density within a field, it is a technical problem also with the important quality control top of a fuel cell that the distribution evaluates whether it is the inside of a normal range, and grasps. Thus, distribution of the generation-of-electrical-energy current density in a fuel cell is an index important when evaluating the property of a fuel cell.
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[0006] In addition, distribution of the hydrogen concentration in fuel gas by this invention person or the oxygen density distribution in oxidizer gas is measured, current density distribution is searched for from the distribution, and there is the approach (refer to Japanese Patent Application No. No. 26414 [seven to]) of supervising the abnormalities inside a fuel cell.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to this invention, it is (1). The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The load current of a fuel cell is changed in time. A fuel electrode substrate or an oxidizer electrode substrate, By calculating the generating heating value in the location from the time amount variation of temperature which measures the temperature in the arbitration location within one which is chosen from the group which consists of a reactant gas conduction slot and an electrolyte layer of fields, and follows the temporal response of the load current Since the generation-of-electrical-energy current density distribution within a field is measured, the abnormality is detected and the abnormalities of a fuel cell are supervised The abnormality monitor approach that the current density distribution within the field of a fuel cell can measure correctly, can evaluate by the simple approach, and grasps the existence of the abnormalities of a fuel cell exactly by it will be acquired.
[0026] (2) Moreover, the fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The thermometry component which measures the temperature in the arbitration location within one which is chosen from the group which consists of the above-mentioned fuel electrode substrate or an oxidizer electrode substrate, a reactant gas conduction slot, and an electrolyte layer in the emergency supervisory equipment of a fuel cell of fields, for example, a thermocouple, Having and constituting the measuring instrument which measures the alternating current component of the detection output of this thermometry component, and the electronic load equipment which controls the load current of the above-mentioned fuel cell, then the emergency supervisory equipment which the existence of the abnormalities of a fuel cell can grasp exactly will be obtained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As mentioned above, in the abnormality monitor of the conventional fuel cell, the resistance fall of potential inside a fuel cell is measured, and the approach of evaluating current density and supervising abnormalities from the value, is taken. However, it is impossible for the path and area in which a current flows in the case of measurement of resistance fall of potential to change with measuring points of resistance fall of potential, and to convert resistance fall of potential into current density correctly by this approach, since it is unknown. Therefore, since the field internal division cloth of the current density distribution acquired by this measuring method is accompanied by the great error, the abnormality monitor approach of the fuel cell by the current density of this measuring method has the trouble that accuracy is missing.
[0008] Moreover, in the approach of supervising the abnormalities inside a fuel cell in quest of current density distribution from distribution of the hydrogen concentration in fuel gas, or the oxygen density distribution in oxidizer gas, since the method of inserting for example, a stainless steel capillary in the interior of a fuel cell, and extracting and analyzing sample gas is taken, there is a difficulty that a certain amount of time amount is needed for searching for the distribution within a field.
[0009] This invention was made in consideration of the difficulty of the conventional technique like the above, and by the simple approach, generating current density distribution of the inside of the field of a fuel cell and the direction of a laminating is measured correctly, and it aims at offering the abnormality monitor approach of a fuel cell that the existence of the abnormalities of actuation of a fuel cell is supervised exactly, and its equipment.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, it sets to this invention. (1) The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, and the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, The cel which consists of an electrolyte layer pinched by a fuel electrode and the oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The load current of a fuel cell is changed in time. A fuel electrode substrate or an oxidizer electrode substrate, By calculating the generating heating value in the location from the time amount variation of temperature which measures the temperature in the arbitration location within one which is chosen from the group which consists of a reactant gas conduction slot and an electrolyte layer of fields, and follows the temporal response of the load current Suppose that the generation-of-electrical-energy current density distribution within a field is measured, the abnormality is detected, and the abnormalities of a fuel cell are supervised. Moreover, (2) The fuel electrode which consists of a fuel electrode catalyst bed and a fuel electrode substrate, The cel which consists of an electrolyte layer pinched by the oxidizer electrode which consists of an oxidizer electrode catalyst bed and an oxidizer electrode substrate, and a fuel electrode and an oxidizer electrode Conduction of the fuel gas is carried out to the fuel gas conduction slot with which came to carry out two or more laminatings, and the fuel electrode was equipped. In the fuel cell which carries out conduction of the oxidizer gas to the oxidizer gas conduction slot with which the oxidizer electrode was equipped, and transforms the reaction energy of these reactant gas into power according to an electrochemical operation The thermometry component which measures the temperature in the arbitration location within one which is chosen from the group which consists of the above-mentioned fuel electrode substrate or an oxidizer electrode substrate, a reactant gas conduction slot, and an electrolyte layer in the emergency supervisory equipment of a fuel cell of fields, for example, a thermocouple, Suppose that the measuring instrument which measures the alternating current component of the detection output of this thermometry component, and the electronic load equipment which controls the load current of the above-mentioned fuel cell are had and constituted.
[0011] the above (1) like -- if an approach is used, since the generating heating value in the location of the arbitration in an electrode surface can be computed theoretically and the generating heating value of each part of a fuel cell is proportional to generation-of-electrical-energy current density under a certain approximation on the other hand from the time amount variation of temperature which follows the temporal response of the load current, it is possible to ask for the generation-of-electrical-energy current density in this location. Therefore, the generation-of-electrical-energy current density distribution in an electrode surface can be searched for, and the existence of the

abnormalities in a fuel cell can be detected.

[0012] In this approach, the generating heating value of the location can be known from the time amount variation of the temperature accompanying the temporal response of the load current based on the principle explained below. That is, it becomes that change of terminal voltage V [as opposed to / solve and / load current consistency / of the single cel of a phosphoric acid fuel cell / J [kA/m2]] [V] to which it was shown in drawing 9 , i.e., a voltage-current consistency property, (V-J property) is drawing 11 . Terminal voltage V falls under the effect of internal resistance etc. with the increment in the load current consistency J. Generated output consistency P1 per unit area [W/m2] and loss power flux density P2 [kW/m2] is expressed with a degree type, respectively.

[0013]

[Equation 1] P1 =JxV (1) P2 =Jx (1.23-V) (2) P2 Since it is equal to the heating value generated inside a fuel cell, it is a formula (2). By trying to double the V-J property of drawing 11 shows that a generating heating value also increases by the increment in current density J. since the terminal voltage within an electrode surface serves as about 1 law by within the limits which is several mV with the phosphoric acid fuel cell of structure as shown especially in drawing 9 when the resistivity of a base material is sufficiently small -- generated output consistency P1 A generating heating-value consistency will be proportional to current density J mostly.

[0014] Now, when distribution of current density J exists within an electrode surface, the heating-value distribution by loss power is formed. The temperature distribution decided by this heating-value distribution and boundary condition turn into steady temperature distribution within a field. On the other hand, when an alternating current-modulation is applied, the temperature distribution of each point within a field are expressed with the sum of the alternating current component TAC which synchronized with the steady temperature distribution TDC decided by the current density JDC averaged in time, and the modulation current density JAC to the load current, so that it may illustrate to drawing 4 . Since distribution of the alternating current component of temperature is decided by alternating current thermal diffusion length mu [m] decided by modulation frequency, it is independent of steady temperature distribution. here -- thermal diffusion length [of the matter] mu [m] -- in k [W/m K] and a consistency, thermal conductivity will be given [heat capacity / rho [kg/m3] and] by the degree type, if C [J/m3] and modulation frequency are set to f [Hz] and a circular constant is set to pi.

[0015]

[Equation 2] mu = [k/(pifrhoC)] 1/2 Thermal diffusion length becomes short, so that (3), i.e., modulation frequency, is high, and temperature distribution will be determined by distribution of a heat source rather than boundary condition. [f] That is, when the load current is modulated on a frequency high enough, it can be considered that distribution of the alternating current component of the temperature produced in connection with this is generating heating-value distribution, therefore current density distribution.

[0016] moreover, the above (2) like -- the temperature of either the electrode substrate of a fuel cell, a gas conduction slot or an electrolyte layer being measured, for example, with the thermometry component which consists of a thermocouple If it has the measuring instrument which measures the alternating current component of the detection output of a thermometry component, and electronic load equipment which controls the load current of a fuel cell and the emergency supervisory equipment of a fuel cell is constituted Since the load current modulated on the high frequency with electronic load equipment is impressed to a fuel cell, the produced temperature fluctuation will be detected with a thermometry component, the alternating current component will be measured with a measuring instrument and current density will be known, the abnormalities produced within the fuel cell can be grasped exactly.

[0017]

[Embodiment of the Invention] Hereafter, the gestalt of operation of the abnormality monitor

approach of the fuel cell of this invention and its equipment is explained using a drawing. Drawing 1 is the mimetic diagram showing the basic configuration of the emergency supervisory equipment used for the abnormality monitor approach of the fuel cell of this invention. The fuel cell with which 21 was manufactured experimentally, the electronic load equipment with which 22 controls the load current of a fuel cell, The thermocouple for thermometries with which 23 was inserted in the fuel cell, the multiplexer as which 24 chooses the output voltage of a thermocouple, the direct-current-voltage meter which measures an in one direction flowed part of the output voltage of the thermocouple with which 25 was chosen, and 26 are alternating-voltage meters which measure the alternating component of the output voltage of the selected thermocouple.

[0018] It is a phosphoric acid fuel cell, and a fuel cell 21 carries out the laminating of five single cels, the 1st cel 31 - the 5th cel 35, as shown in drawing 2 R> 2, it arranges a cooling plate 36 up and down, respectively, and is formed. It solves, and consists of a configuration and the electrode surface product of a fuel cell of the area of 2 (1mx1m), among those a generation-of-electrical-energy field is [which showed each five single cel by which the laminating was carried out to drawing 9] 2 0.81m 1m (0.9 mx0.9 m). As fuel gas, it is hydrogen. 65 % and carbon dioxide As oxidizer gas, air is used for the mixed gas of 35 % again. Moreover, hydrogen utilization factor at the time of a generation of electrical energy 80 % and ratio of oxygen utilization It is 50 %.

[0019] Moreover, the fuel cell 21 equips with a total of 13 thermocouples 23 the 3rd cel 33 located in a center section among five single cels by which the laminating was carried out. These thermocouples 23 are all the outer diameters of 0.6mm. It is chromel-alumel thermocouple with a stainless steel sheath, it inserts in the oxidizer gas conduction slot (1a of drawing 9) of an oxidizer electrode, and the element is distributed so that it may become the location shown in drawing 3 by the sunspot. In addition, in drawing 3 , 33 shows the 3rd cel, therefore an electrode field, and 40 shows the generation-of-electrical-energy field.

[0020] In this configuration, fuel gas and air were supplied to the fuel cell 21, the load current was controlled by electronic load equipment 22, and the electrode temperature of each point of measurement was measured with it. The load current is between 10 [ms], as shown in drawing 4 . Between [after holding to 2.0 [kA]] ten [ms] The cycle held to 2.8 [kA] shall be repeated. Namely, average The load current of 2.4 [kA] was modulated on the frequency of 50 [Hz]. The output of each thermocouple 23 was led to the multiplexer 24, the dc component of the output voltage was measured with direct current voltage 25 [a total of] with the change, and the alternating current component was measured with alternating voltage 26 [a total of].

[0021] When measured the above condition, about the dc component of temperature which changes in time, the field internal division cloth like drawing 5 was obtained, and the field internal division cloth like drawing 6 was obtained about the alternating current component. Drawing 5 and drawing 6 are the generation-of-electrical-energy field 40. It is what displayed the temperature of the part of 0.9mx0.9 m, and the contour line computed from such measured value is displayed on the measured value of the location corresponding to the point of measurement shown in drawing 3 , and a list, and all of the unit of the described numeric value are [**s]. In drawing 5 , it is characteristic to decrease as the maximum upstream section of fuel gas and air serves as max and goes down-stream by drawing 6 to the neighborhood of a point of (300 mm, 300mm) on drawing near the upstream of fuel gas and air showing maximum.

[0022] On the other hand, perform numerical simulation, and the field internal division cloth of the temperature acquired about the above-mentioned fuel cell 21 based on change in the field of the hydrogen concentration in the fuel gas accompanying electrochemical reaction, change in the field of the oxygen density in air, or the boundary condition in an electrode edge is shown in drawing 7 , and the field internal division cloth of current density is shown in drawing 8 . It is what all displayed the distribution in the interior of the generation-of-electrical-energy field 40 as with the contour line, and the unit of the current density which showed the unit of the temperature shown in drawing 7 to [**]

and drawing 8 is [kA/m2].
[0023] As it was predicted theoretically that drawing 6 was compared with drawing 8 , it turns out that distribution (drawing 6) of the alternating current component of the temperature measured by the above-mentioned approach is well in agreement with the field internal division cloth (drawing 8) of current density. That is, the variation of a sink and temperature is measured for the load current modulated to the fuel cell, distribution is searched for, and the field internal division cloth of current density is called for by distributing proportionally the generation-of-electrical-energy current of a fuel cell in a field. Therefore, if an above-mentioned approach is used, the abnormalities of the current density inside a fuel cell will be detected correctly, and can supervise the abnormalities of a fuel cell exactly.
[0024] In addition, in the above-mentioned example, although the thermometry component which becomes the 3rd cel 33 of a fuel cell 21 from a thermocouple 23 shall be distributed, if a thermometry component is allotted to other single cels, the abnormalities between the single cels of the direction of a laminating will be detected. Moreover, although the thermometry component set to oxidizer gas conduction slot 1a from a thermocouple 23 was inserted and temperature is measured in the above-mentioned example, the effectiveness same also as measuring the temperature of not only a reactant gas conduction slot but an electrode substrate or an electrolyte layer is acquired. It is Princeton AppliedReseach as a measuring instrument of the alternating current component of a temperature change further again instead of an alternating-voltage meter. If the lock in amplifier currently manufactured at the shrine or the ENUEFU circuit design block company is used, the output voltage of the thermocouple which synchronized with change of the load current will be more highly precise, can measure, and is effective by the monitor of the abnormalities of a fuel cell.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

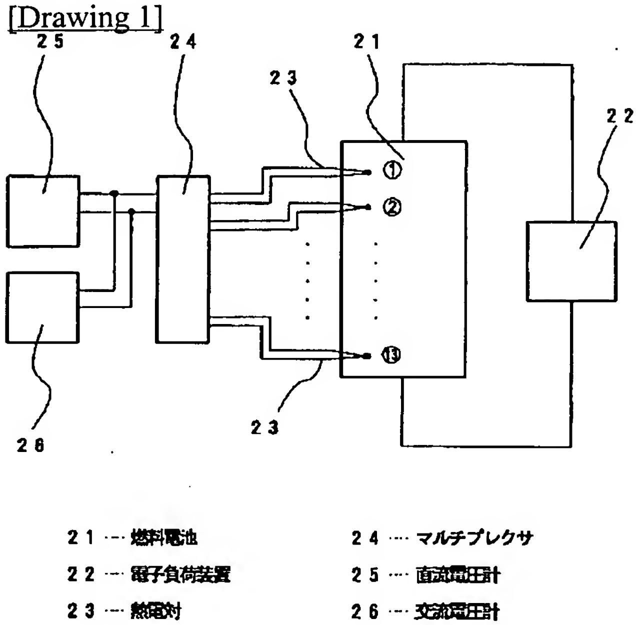
[Brief Description of the Drawings]
[Drawing 1] The mimetic diagram showing the basic configuration of the emergency supervisory equipment used for the abnormality monitor approach of the fuel cell of this invention
[Drawing 2] The sectional view of the fuel cell incorporating the emergency supervisory equipment of drawing 1
[Drawing 3] The plot plan in the electrode surface of the thermocouple built into the 3rd cel of the fuel cell of drawing 2
[Drawing 4] The property Fig. of time amount change of the load current of a fuel cell controlled by the electronic load equipment of the emergency supervisory equipment of drawing 1
[Drawing 5] The distribution map in the electrode surface of the dc component of the temperature measured with the thermocouple built into the 3rd cel when conduction of the load current of drawing 4 was carried out to a fuel cell
[Drawing 6] The distribution map in the electrode surface of the alternating current component of the temperature measured with the thermocouple built into the 3rd cel when conduction of the load current of drawing 4 was carried out to a fuel cell
[Drawing 7] The distribution map in the electrode surface of the electrode temperature of the fuel cell of drawing 2 obtained by numerical simulation
[Drawing 8] The distribution map in the electrode surface of the current density of the fuel cell of drawing 2 obtained by numerical simulation
[Drawing 9] The perspective view showing typically the basic configuration of the single cel of a phosphoric acid fuel cell
[Drawing 10] The important section sectional view of a fuel cell showing the measurement approach of current density distribution of the conventional fuel cell
[Drawing 11] The property Fig. showing the typical voltage-current consistency property of the single cel of a phosphoric acid fuel cell
[Description of Notations]
1 Oxidizer Electrode Substrate
1a Oxidizer gas conduction slot
2 Oxidizer Electrode Catalyst Bed
3 Electrolyte Layer
4 Fuel Electrode Catalyst Bed
5 Fuel Electrode Substrate
5a Fuel gas conduction slot
21 Fuel Cell
22 Electronic Load Equipment
23 Thermocouple
24 Multiplexer

25 Direct-Current-Voltage Meter
26 Alternating-Voltage Meter
31 1st Cel
32 2nd Cel
33 3rd Cel
34 4th Cel
35 5th Cel
36 Cooling Plate
40 Generation-of-Electrical-Energy Field

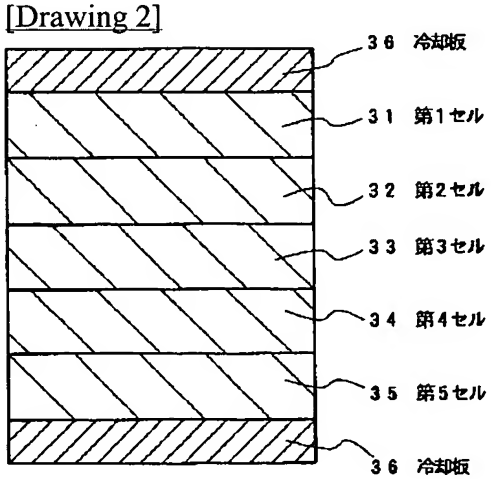
[Translation done.]

DRAWINGS

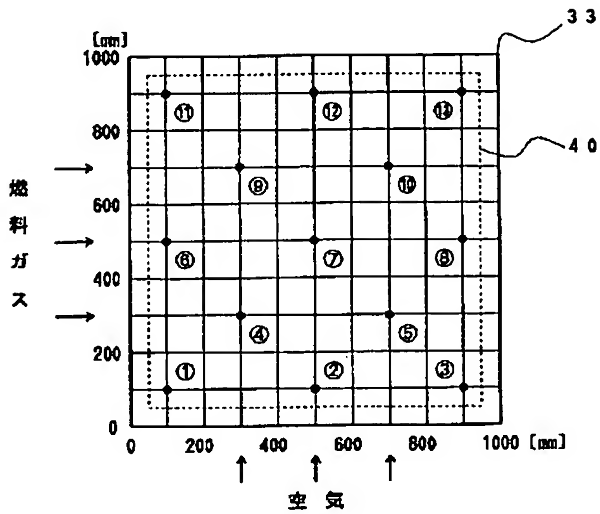
[Drawing 1]



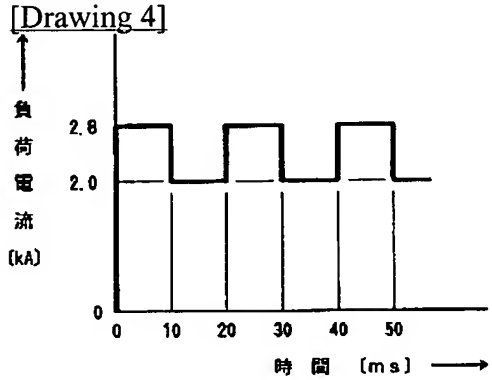
[Drawing 2]



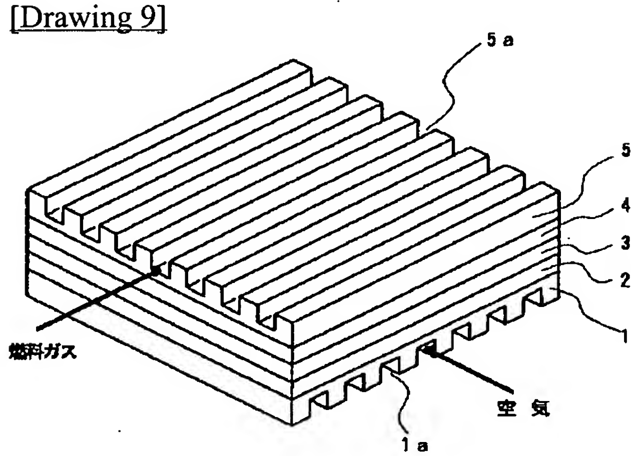
[Drawing 3]



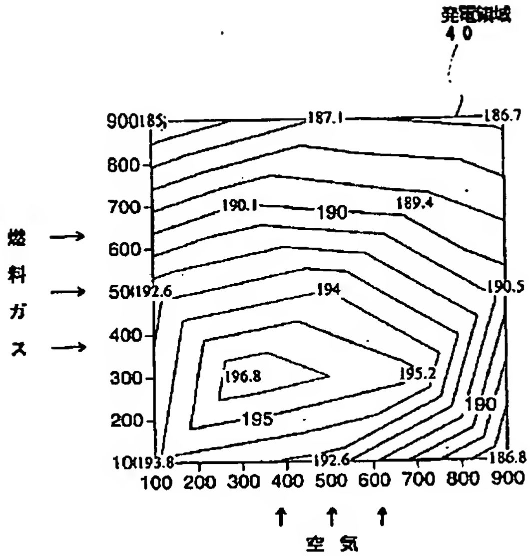
[Drawing 4]



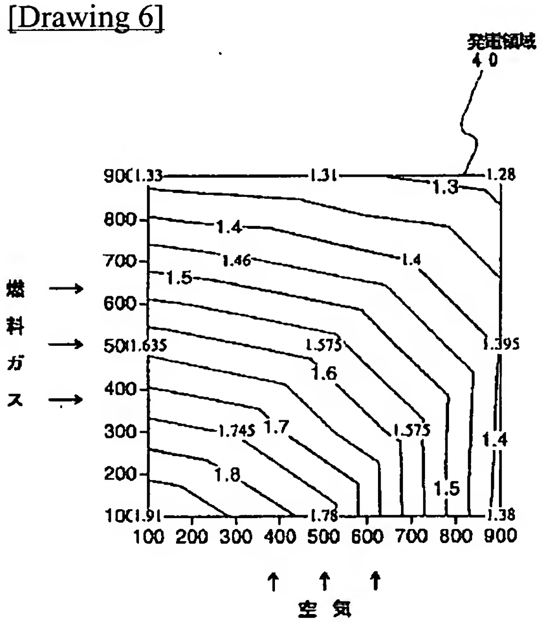
[Drawing 9]



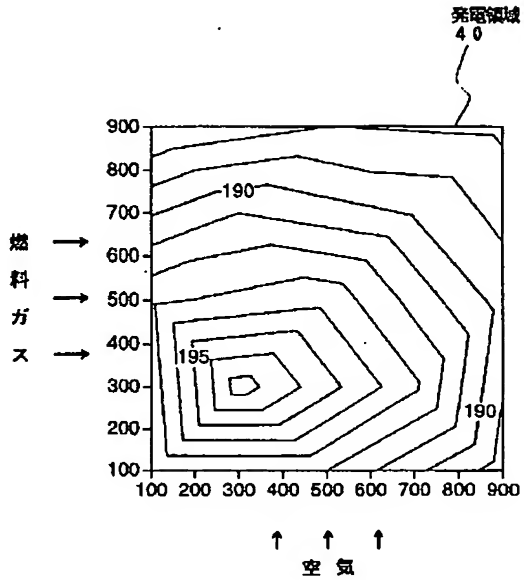
[Drawing 5]



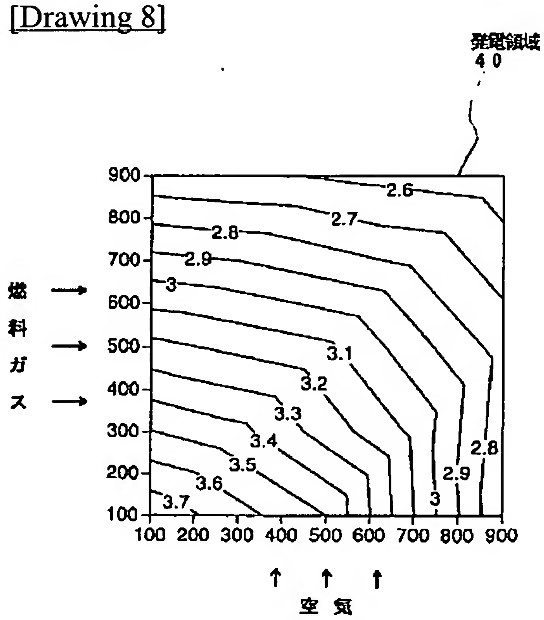
[Drawing 6]



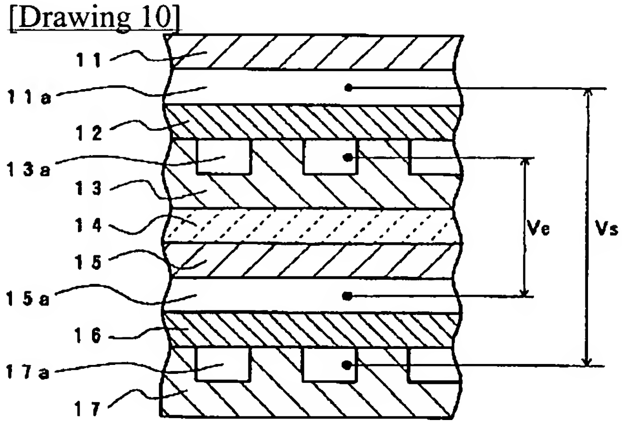
[Drawing 7]



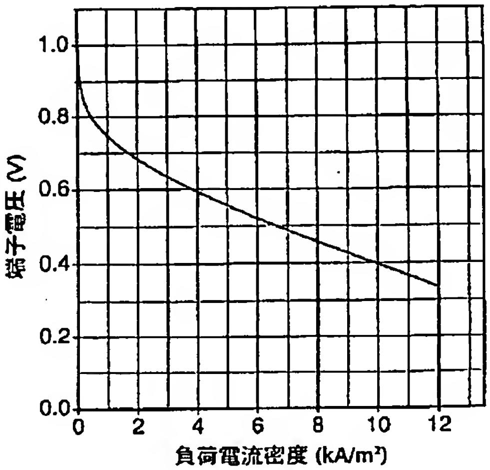
[Drawing 8]



[Drawing 10]



[Drawing 11]



[Translation done.]